

More about the Buthoidea of Madagascar, with special references to the genus *Tityobuthus* Pocock (Scorpiones, Buthidae)

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More about the Buthoidea of Madagascar, with special references to the genus *Tityobuthus* Pocock (Scorpiones, Buthidae). - A revised diagnosis of the genus *Tityobuthus* Pocock is given and three new species, i.e. *T. manonae* sp. n., *T. griswoldi* sp. n. and *T. monodi* sp. n., are described. For two species previously associated with *Tityobuthus*, two new genera are established, i.e. *Troglotityobuthus* gen. n. for *Tityobuthus gracilis* (Fage) (described under *Babycurus gracilis*) and *Palaeogrosplus* gen. n. for *Tityobuthus copalensis* Lourenço. Phylogenetic relationships between Madagascan scorpions and those in Africa, South America and Asia are discussed. Revised keys are given for the genera of Buthoidea present in Madagascar and for the species of the genus *Tityobuthus*.

Key-words: Scorpiones - Buthidae - Microcharmidae - taxonomy - Madagascar.

INTRODUCTION

The genus *Tityobuthus* was established by Pocock (1893) for *Tityobuthus baroni* (Pocock, 1890) previously included in the genus *Rhoprurus* Karsch, 1886, because this name was already preoccupied by that of a snake genus, *Rhoprura* Peters, 1858 (Vachon, 1979). Confusion existed about the genera *Tityobuthus* Pocock, *Pseudobuthus* Pocock and *Odonturus* Karsch until they were revised by Vachon (1979), who finally included only two species in the genus *Tityobuthus*, i.e. *Tityobuthus baroni* (Pocock, 1890) and *Tityobuthus gracilis* (Fage, 1946). The latter was originally described in the genus *Babycurus* Karsch, 1886.

In the last few years, and in particular since the scorpion fauna of Madagascar was summarised by Lourenço (1996a), increasing numbers of new species have been described in the genus *Tityobuthus*. These are: *T. guillaumeti* Lourenço, *T. pococki* Lourenço, *T. lucileae* Lourenço, *T. copalensis* Lourenço, *T. petrae* Lourenço, *T. parrilloi* Lourenço, *T. judsoni* Lourenço, *T. dastychi* Lourenço and *T. ivohibe* Lourenço & Goodman. This shows that this genus of micro-scorpions is very rich in species (Lourenço, 1995, 1996a,b,c, 1997a; Lourenço & Goodman, 1999). The same phenomenon has already been observed in other micro-scorpion genera including

Ananteris Thorell. The number of species known in that genus increased from 3 to 23 within twenty years (Lourenço, 1993, 1994, 1997b, 1999a, b; Lourenço & Monod, 1999). The recent discovery of three additional new species of the genus *Tityobuthus* pointed out the necessity for a revision of this genus. A reanalysis of characters showed that two species previously associated with *Tityobuthus*, i.e. *T. gracilis* (Fage) and *T. copalensis* Lourenço, deserve a separate taxonomic position.

Revised keys to the genera of Buthoidea present in Madagascar, and to the known species of the genus *Tityobuthus* are also provided in the following. Possible phylogenetic links and associations between Madagascan lineages and those present in Africa, South America and Asia are pointed out.

TAXONOMY OF *TITYOBUTHUS*

Tityobuthus Pocock, 1893

Type species: Rhoptrurus baroni Pocock, 1890; described from Madagascar.

Revised diagnosis: Scorpions of small size, 20-25 mm in total length. Carapace with a moderate to strong concavity; median ocular tubercule markedly anterior to the center of the carapace; three pairs of lateral eyes. Chelicerae with dentition according to the buthid pattern (Vachon, 1963). Pedipalps slender and moderately long; movable fingers with 7 or 8 slightly oblique, almost straight rows of granules. Tibial spurs present in some species, reduced in others and absent in a few. Sternum sub-triangular. Pectines with 11-25 teeth; fulcra present or absent according to species; basal middle lamellae of female never dilated. Sternites with very short linear stigmata. Telson with a very slender vesicle; aculeus long and moderately curved, with a spinoid subaculear tooth of variable size. Trichobothrial pattern of type A- α - orthobothriotaxic.

Remarks: The presence or absence of tibial spurs is a particularity of this genus since this character has always been considered to be invariable within a given genus. The fact that in *Tityobuthus* species certain characters are present in different states had already lead Vachon (pers. comm.) to consider a division of the genus into two or more genera. I have, however, some hesitations about taking this step. *Tityobuthus*, like other buthid genera, may belong to archaic lineages in which some characters are not precisely differentiated (Lourenço, 1995, 1996a).

Distribution: Madagascar.

DESCRIPTION OF THREE NEW SPECIES

Tityobuthus manonae sp. n.

Figs 12-16

Type: MADAGASCAR, Mandena, Fort Dauphin (littoral forest 10 km north of Fort Dauphin), holotype male, 6-12/1/1999 (J.-B. Ramanamanjato leg.)¹; deposited in the Muséum d'histoire naturelle, Genève (MHNG).

Etymology: Patronym in honor of Dr Manon Vincelette of QIT Minerals-Madagascar, Montreal, Canada.

¹ Collected with 11 specimens of *Grosphus hirtus* Kraepelin, also deposited in MHNG.

Description (based on male holotype): Measurements in Table I.

Coloration. Ground colour yellowish, symmetrically marbled with a dark reddish brown, giving an overall spotted appearance. Prosoma: carapace yellowish, moderately spotted; eyes surrounded by black pigment. Mesosoma: yellowish, with four longitudinal brown stripes, i.e. two central and two lateral ones. Metasoma: segments I to IV yellowish; V yellowish to reddish yellow. Vesicle as segment V. Venter yellowish, with a number of spots on sternites VI and VII. Chelicerae yellowish, with dark spots on the lateral edges; fingers reddish. Pedipalps: yellowish, with several dark spots on femur and tibia; chela less densely spotted; hands yellowish; fingers much darker, reddish-brown, with the extremities yellowish. Legs yellowish, with diffuse fuscous spots.

TABLE I
Measurements (in mm) of male holotypes of the described species

| | <i>T. manonae</i> | <i>T. griswoldi</i> | <i>T. monodi</i> |
|-----------------------|-------------------|---------------------|------------------|
| Carapace: | | | |
| - length | 2.6 | 2.6 | 1.9 |
| - anterior width | 1.8 | 2.1 | 1.5 |
| - posterior width | 2.7 | 2.8 | 2.0 |
| Metasomal segment I: | | | |
| - length | 1.6 | 1.5 | 1.1 |
| - width | 1.7 | 1.5 | 1.2 |
| Metasomal segment V: | | | |
| - length | 3.3 | 3.4 | 2.5 |
| - width | 1.3 | 1.4 | 1.0 |
| - depth | 1.2 | 1.3 | 0.9 |
| Vesicle: | | | |
| - width | 0.8 | 1.0 | 0.7 |
| - depth | 0.9 | 1.1 | 0.7 |
| Pedipalp: | | | |
| - Femur length | 2.2 | 2.6 | 1.8 |
| - Femur width | 0.7 | 0.7 | 0.5 |
| - Tibia length | 2.9 | 3.2 | 2.6 |
| - Tibia width | 1.2 | 1.3 | 0.8 |
| - Chela length | 4.1 | 5.0 | 3.4 |
| - Chela width | 0.9 | 1.2 | 0.6 |
| - Chela depth | 0.8 | 1.0 | 0.6 |
| Movable finger length | 2.7 | 3.3 | 2.4 |

Morphology. Carapace moderately to weakly granular; anterior margin with a weakly to moderately pronounced median concavity. Anterior median superciliary, posterior median keels and all furrows moderate to feeble. Median ocular tubercle distinctly anterior to the center of the carapace; median eyes separated by one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular. Mesosoma: tergites moderately granular. Median keel moderate to strong on all tergites; confluent vesti-

gial keels present. Tergite VII pentacarinat. Venter: genital operculum longitudinally divided. Pectines: pectinal tooth count 19/20; basal middle lamellae not dilated; fulcra present. Sternites smooth or with very weak granulations and small, elongate stigmata; VII with two keels. Sternite V with a large smooth, bright zone on posterior edge. Metasoma: segments I to III with 10 keels, crenulate. Segment IV with 8 keels, crenulate. Intercarinal spaces weakly to moderately granular. Segment V smooth and rounded. Telson smooth, without punctuations, with a long but moderately curved aculeus; subaculear tooth very small and slightly rhomboid. Cheliceral dentition characteristic of the family Buthidae (see Vachon, 1963); basal teeth of movable fingers reduced and almost fused; ventral surfaces of finger and manus almost without setae. Pedipalps: femur pentacarinat; tibia and chelae with some keels, moderately crenulate; internal face of tibia with six spinoid granules; all faces moderately granular; movable fingers with 8/9 oblique rows of granules. Trichobothriotaxy; orthobothriotaxy A- α (cf. Vachon, 1973, 1975). Legs: tarsus with numerous fine median setae ventrally. Pedal and tibial spurs present but reduced.

Relationships: From general morphology *T. manonae* sp. n. appears to be most closed related to *T. petrae* Lourenço, 1996. The two can be readily distinguished by the following features: (i) the new species is much larger (see Table I, Lourenço, 1996a), (ii) the presence of a single conspicuous white smooth and bright central zone on sternite V of the new species, whereas in *T. petrae* this zone is reduced and there are two small rounded white patches laterally.

***Tityobuthus griswoldi* sp. n.**

Figs 17-21

Types: MADAGASCAR, Prov. Fianarantsoa, P.N. Ranomafana, Talatakely (21°15,3' S - 47°25,9' E), holotype male 9-26-IV-1998 (pitfall traps; C.E. Griswold, D.H. Kavanaugh, N.D. Penny & M.J. Raheirilalao leg.); deposited in the California Academy of Sciences, San Francisco (CAS). Paratypes: Same data as for the holotype. 1 male, 19-30/IV/1998, deposited in MHNG; 1 juvenile; 3 juveniles, 19-30/IV/1998 (21°14,9 S - 47°25,6 E), deposited at the CAS.

Etymology: Patronym in honor of Dr Charles E. Griswold of the California Academy of Sciences.

Description (based on male holotype): Measurement in Table I.

Coloration. Colour yellow, symmetrically marbled with dark brown, giving an overall spotted appearance. Prosoma: carapace yellowish, densely spotted; eyes surrounded by black pigment. Mesosoma: yellowish with three longitudinal brown stripes, the median one indistinctly divided. Metasoma: segments I to V yellowish; vesicle as is segment V. Venter yellowish, with a number of dark spots on all sternites. Sternite V with a large bright white zone in the posterior region and with two small rounded white bright zones laterally. Chelicerae yellow, with dark spots in median zone; fingers reddish. Pedipalps yellowish, with several dark spots on femur and tibia; chela less densely spotted; hands yellowish, fingers much darker, reddish-brown. Legs yellowish, with diffuse fuscous spots.

Morphology. Carapace moderately to weakly granular; anterior margin with moderate median concavity. Anterior median superciliary, posterior median keels and

all furrows moderate to weak. Median ocular tubercle distinctly anterior to center of carapace; median eyes separated by one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular to pentagonal. Mesosoma: tergites weakly granular. Median keel moderate in all tergites. Tergite VII pentacarinat. Venter: genital operculum longitudinally divided. Pectines: pectinal tooth count 14/14; basal middle lamellae not dilated; fulcra present. Sternites weakly granular with small and moderately elongate stigmata; VII without keels. Sternite V with smooth, bright white zone in posterior region and two similar small rounded zones laterally. Metasoma: segments I and II with 10 keels, crenulate. Segments III and IV with 8 keels, crenulate. Intercarinal spaces weakly to moderately granular. Segment V smooth and rounded. Telson smooth without punctuations, with fairly short, moderately curved aculeus; subaculear tooth strong, slightly spinoid. Cheliceral dentition characteristic of the family Buthidae (cf. Vachon, 1963); basal teeth of movable fingers small; ventral surface of finger and manus with setae. Pedipalps: femur pentacarinat; tibia and chela with some keels but moderately crenulate; internal face of tibia with four spinoid granules; all faces feebly granular; movable fingers with 8/9 oblique rows of granules. Trichobothriotaxy; orthobothriotaxy A- α (cf. Vachon, 1973, 1975). Legs: tarsus with numerous fine median setae ventrally. Pedal and tibial spurs present but reduced.

Variation: the pectinal tooth count in the paratypes is: 13-13, 14-13, 12-14, 14-14 (x2).

Relationships: From general morphology *T. griswoldi* sp. n. appears to be most closely related to *T. dastychi* Lourenço. The two species can, however, be readily distinguished by the following features: (i) a different shape of the pectines and a different number of teeth, 12 to 14 in the new species and 18 in *T. dastychi*. (ii) the presence of a single conspicuous smooth bright white zone on sternite V of *T. dastychi*, while in the new species this central zone is reduced and associated with two small rounded smooth bright white zones laterally.

Tityobuthus monodi sp. n.

Figs 22-26

Type: MADAGASCAR, Prov. Toamasina, F.C. Andriantantely (18°41,7' S - 48°48,8' E), 530 m, holotype male, 7-10-XII-1998 (H. J. Ratsirarson leg.); deposited in MHNG.

Etymology: Patronym in honor of M. Lionel Monod of the Muséum d'histoire naturelle de Genève.

Description (based on male holotype): Measurement in Table I.

Coloration. Ground colour yellow, symmetrically marbled with dark brown, giving an overall spotted appearance. Prosoma: carapace yellowish, densely spotted; eyes surrounded by black pigment. Mesosoma: yellowish, with three longitudinal brown stripes more or less inter-linked by confluent stripes. Metasoma: segments I to V yellowish; vesicle yellowish but lighter than segment V. Venter yellowish, with all sternites densely spotted. Sternite V with only a vestigial bright white zone in posterior region. Chelicerae yellowish, densely spotted in central zone; fingers reddish. Pedipalps yellowish, with several dark spots on femur and tibia; chela less densely spotted; hands light yellow; fingers much darker, reddish, with the extremity more yellow. Legs yellowish, with diffuse fuscous spots.

Morphology. Carapace moderately to weakly granular; anterior margin with weak to moderate median concavity. Anterior median superciliary, posterior median keels and all furrows moderate to weak. Median ocular tubercle distinctly anterior to center of carapace; median eyes separated by more than one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular to pentagonal. Mesosoma: tergites weakly granular. Median keel very weak in all tergites. Tergite VII pentacarinat. Venter: genital operculum longitudinally divided. Pectines: pectinal tooth count 16/16; basal middle lamellae not dilated; fulcra very reduced, almost vestigial. Sternites smooth, with small elongate stigmata; VII without keels. Metasoma: segments I and II with 10 keels, crenulate. Segments III and IV with 8 keels crenulate. Intercarinal spaces weakly granular. Segment V smooth and rounded. Telson smooth, without punctuations, with moderately long, curved aculeus; subaculear tooth strong and spinoid. Cheliceral dentition characteristic of the family Buthidae (cf. Vachon, 1963); basal teeth on movable fingers small; ventral surface of finger and manus with some setae. Pedipalps: femur pentacarinat; tibia and chela with some keels but moderately crenulate; internal face of tibia with four/five granules but not spinoid; all faces weakly granular, almost smooth. Movable fingers with 8/9 oblique rows of granules. Trichobothriotaxy; orthobothriotaxy A- α (cf. Vachon, 1973, 1975). Legs: tarsus with numerous fine median setae ventrally. Pedal and tibial spurs present but very reduced.

Relationships: *Tityobuthus monodi* appears to be most closed related to *T. guillaumeti* Lourenço. The two species can be readily distinguished by the following features: (i) a different pattern of pigmentation, i.e. the new species is heavily spotted, whereas *T. guillaumeti* is uniformly yellowish, (ii) the different shape of the pectines; in the new species these are small and have vestigial fulcra, whereas in *T. guillaumeti* they are large and the fulcra is completely absent.

DESCRIPTION OF TWO NEW GENERA

Troglotityobuthus gen. n.

Figs 1-7

Type species: *Babycurus gracilis* Fage, 1946; described from Madagascar, Ambilobe, Ankarana, «grotte des Fanihys».

Diagnosis: Scorpions of medium size, 45 mm in total length. Pigmentation almost absent. The whole body flattened dorsally, all appendices long and slender. Carapace with a moderate concavity; very flat dorsally. Median ocular tubercle anterior to center of carapace; three pairs of lateral eyes. Chelicerae with dentition according to the buthid pattern (Vachon, 1963). Pedipalps long and slender; movable fingers very long, with 9/10 slightly oblique, almost straight rows of granules. Tibial spurs present. Sternum triangular. Pectines with 20/20 teeth; fulcra strongly marked; basal middle lamellae not dilated. Sternites with short linear stigmata. Telson with a very slender vesicle; aculeus long and moderately curved, with a spinoid subaculear tooth. Trichobothrial pattern of type A- α - orthobothriotaxic.

Distribution: Madagascar.

Palaeogrosphus gen. n.

Figs 8-11

Type species: Tityobuthus copalensis Lourenço, 1996; described from Madagascar, Diégo-Suarez, region of Antseranana (in copal).

Diagnosis: Scorpions of small size, 20-25 mm in total length. Carapace with a moderate concavity; median ocular tubercle anterior to the center of the carapace; three pairs of lateral eyes. Cheliceral dentition apparently (with some uncertainty) in accordance with the buthid pattern (Vachon, 1963). Pedipalps slender but not long; movable fingers with 10 only slightly oblique, almost straight rows of granules. Tibial spurs not easily discernible, apparently reduced. Sternum sub-pentagonal. Pectines without fulcra; basal middle lamellae moderately dilated. Sternites with short linear stigmata. Telson with a moderately incrassate vesicle; aculeus moderately curved, with a short and slightly rhomboidal subaculear tooth. Trichobothrial pattern of type A- α , probably orthobothriotaxic but not all trichobothria discernible.

Distribution: Madagascar (in recent palaeogeological periods; late Cenozoic-early Pleistocene).

Remark: The character basal middle lamellae moderately dilated, suggests that the new genus is related to the genus *Grosphus*.

BIOGEOGRAPHY

As noted by previous authors (Fage, 1929; Millot, 1948; Vachon, 1979), there are significant affinities between the scorpion faunas of Madagascar and Africa. The following arguments can be given in support of this view. (i) *Grosphus* Simon, one of the most species-rich Madagascan genera, and *Neogrosphus* Lourenço, a genus which probably evolved more recently from *Grosphus*, undoubtedly have close affinities with the African genus *Uroplectes* Peters. These three genera share a very remarkable sexual dimorphism of the pectines (Fage, 1929). The new genus *Palaeogrosphus* gen. n. may represent a primitive element, older than *Grosphus* and *Neogrosphus*, but more data on this sub-fossil genus are needed before a decision can be made (Lourenço, 1995, 1996a), (ii) The recently discovered genus *Pseudouroplectes* Lourenço may also have some affinities with the genus *Uroplectes*. However, the morphology of *Pseudouroplectes* suggests a much more primitive lineage when compared with *Uroplectes* and *Grosphus*, which certainly evolved later (Lourenço, 1995, 1996a). *Pseudouroplectes* corresponds to primitive lineages, which have probably vanished in other regions of the world but are still present in Madagascar. This genus has distant affinities with the microcharmids genus *Microcharmus* Lourenço, but some intermediate elements still have to be identified in the Madagascan Buthoidea. (iii) The genus *Tityobuthus* was phylogenetically poorly defined until recently, but the discovery of several new species has improved our knowledge of this group. Affinities possibly exist with the Gondwanan genus *Ananteris* Thorell, today present in West Africa and South America. *Ananteris* seems to have had its center of origin in the western part of Gondwanaland, which corresponds with present-day South America. More recently, affinities have also been shown between *Ananteris*, *Tityobuthus* and the Himalayan genus *Himalayotityobuthus* Lourenço (Lourenço, 1997c). These three

genera show several primitive characteristics, including small size and the absence of fulcra in the pectines (the absence of fulcra is observed in at least one species of *Tityobuthus*).

The new genus *Troglotityobuthus* gen. n. represents a troglobitic element, which probably derived from epigeal species close to *Tityobuthus*. However, our knowledge of this genus remains extremely incomplete. The discovery of the genus *Microcharmus*, in the north-eastern region of Madagascar, provided the first indication of possible affinities with *Charmus* Karsch in India and Sri Lanka. Both *Microcharmus* and *Charmus* represent primitive lineages whose characteristics (see Lourenço, 1995, 1996a) show that they belong to the most early-derived extant Buthoidea. The descriptions of several other species of *Microcharmus* and the study of the African genus *Akentrobuthus* Lamoral have lead (in a preliminary decision) to the transfer of these two genera to a separate buthoid family, the Microcharmidae (Lourenço, 1998). In a more recent decision, the genus *Akentrobuthus* was replaced in the family Buthidae (Lourenço, 2000) and the Microcharmidae returned again to be represented by relictual elements, present only in Madagascar. At the moment there are no further indications to suggest affinities between Madagascar, Indo-Malayan region and Australia.

CONCLUSIONS

Although this study is only preliminary, the following findings on the Buthoidea of Madagascar can be presented: 1. The majority of the buthoid taxa in Madagascar correspond with primitive lineages which no longer exist in most other regions of the world. 2. Several genera appear to be poor in species. It is, however, reasonable to expect future discoveries of several new species in certain genera of micro-scorpions such as *Tityobuthus*, *Microcharmus* and *Pseudouroplectes*. 3. The number of recorded species is still small, but the faunistic inventories so far carried out are extremely incomplete. 4. Nevertheless the number of genera is significant, even when compared with other well-studied regions of the world. 5. The most remarkable characteristic of the buthoids of Madagascar is the impressive level of endemism, both in species and in genera. This supports the hypothesis of a very early isolation of the island from other land masses.

KEY TO THE GENERA OF BUTHOIDEA PRESENT IN MADAGASCAR

- | | | |
|-----|---|--------------------------------------|
| 1 | Sternum with a triangular shape: Buthidae | 2 |
| (1) | Sternum with a sub-pentagonal to pentagonal shape | Microcharmidae - <i>Microcharmus</i> |
| 2 | Chelae: movable fingers with 10 to 14 oblique rows of granules | 3 |
| (2) | Chelae: movable fingers with 7 or 8 oblique rows of granules | 5 |
| 3 | Carapace distinctly flattened; length of movable finger 3-4 times the length of hand | <i>Troglotityobuthus</i> gen. n. |
| (3) | Carapace not flattened; movable finger 1.5 times longer than hand | 4 |

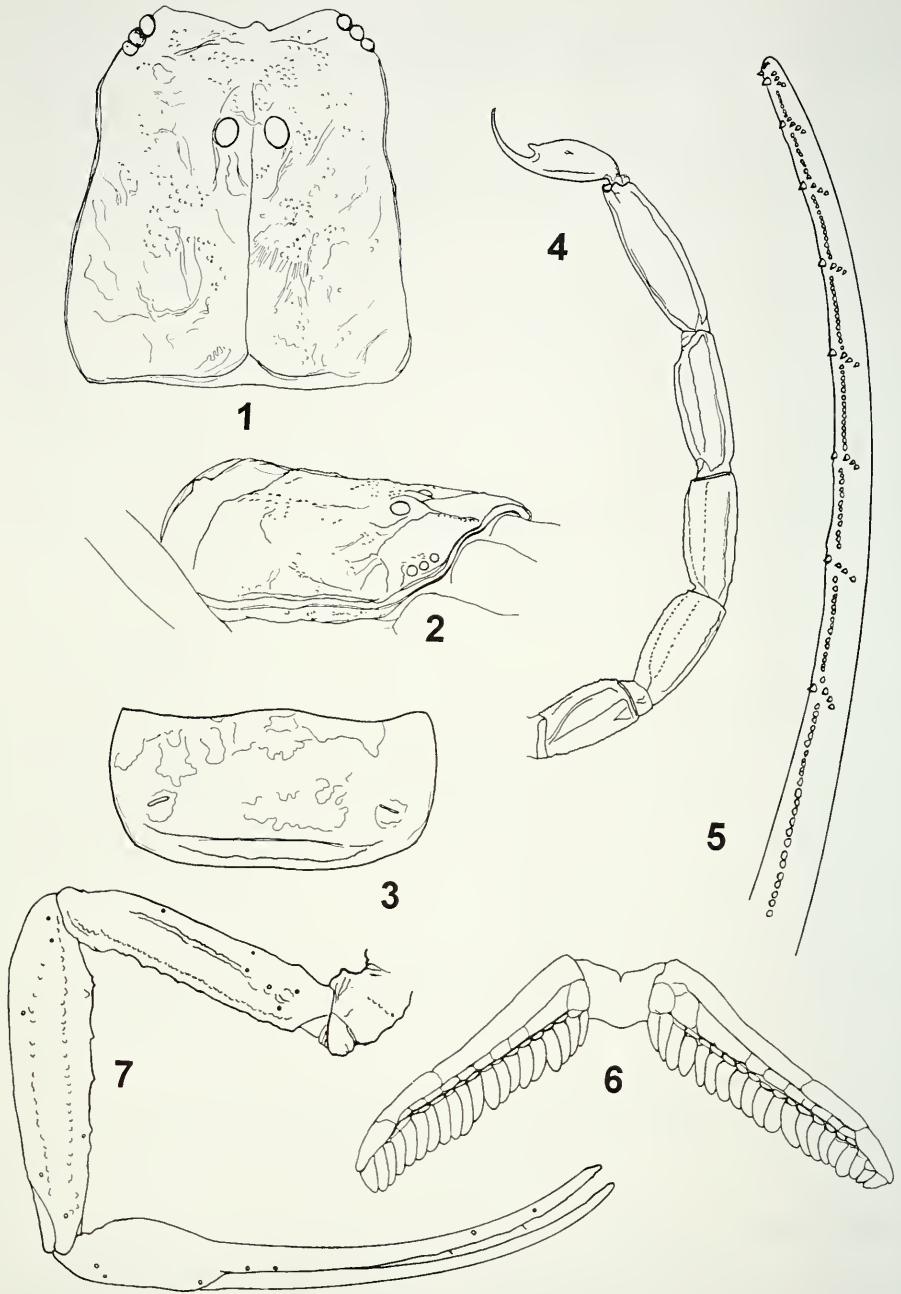
- 4 Telson without subaculear tooth; pectines with fulcra *Grosphus*
 (4) Telson with small subaculear tooth; pectines without fulcra
 *Palaeogrosphus* gen. n.
 5 Telson with moderate to strong subaculear tooth *Tityobuthus*
 (5) Telson without subaculear tooth 6
 6 Pectines of female with basal middle lamellae moderately dilated *Neogrosphus*
 (6) Pectines of female with basal middle lamellae not dilated . . . *Pseudouroplectes*

KEY TO THE SPECIES OF *TITYOBUTHUS*

- 1 Pectines with fulcra vestigial or absent 2
 (1) Pectines with well developed fulcra 3
 2 Fulcra vestigial *monodi* sp. n.
 (2) Fulcra absent *T. guillaumeti*
 3 Tibial spurs absent *T. baroni*
 (3) Tibial spurs present 4
 4 Chelicerae without spots or pigmentation *T. judsoni*
 (4) Chelicerae with dark spots and pigmentation 5
 5 Pectines with 20 or more teeth 6
 (5) Pectines with less than 20 teeth 8
 6 A conspicuous smooth, white and bright central zone on sternite V
 *T. manonae* sp. n.
 (6) No such zone on sternite V 7
 7 Body, pedipalps and legs heavily spotted; pedipalpal chelae short and
 robust; internal face of tibia with four spinoid granules *T. lucileae*
 (7) Body, pedipalps and legs with only vestigial spots; pedipalpal chelae
 long and slender; internal face of tibia with 5 or 6 spinoid granules . *T. pococki*
 8 Pectines with 11 teeth *T. ivohibe*
 (8) Pectines with 12 to 19 teeth 9
 9 Pectines with 12 to 14 teeth 10
 (9) Pectines with 15 to 19 teeth 11
 10 A smooth white central zone on sternite V and two small rounded
 smooth white zones laterally *T. griswoldi* sp. n.
 (10) Sternite V without smooth white zone *T. parrilloi*
 11 Sternite V centrally with a single conspicuous smooth white zone . *T. dastychi*
 (11) Sternite V with a reduced smooth white central zone associated with
 two small rounded smooth white zones laterally *T. petrae*

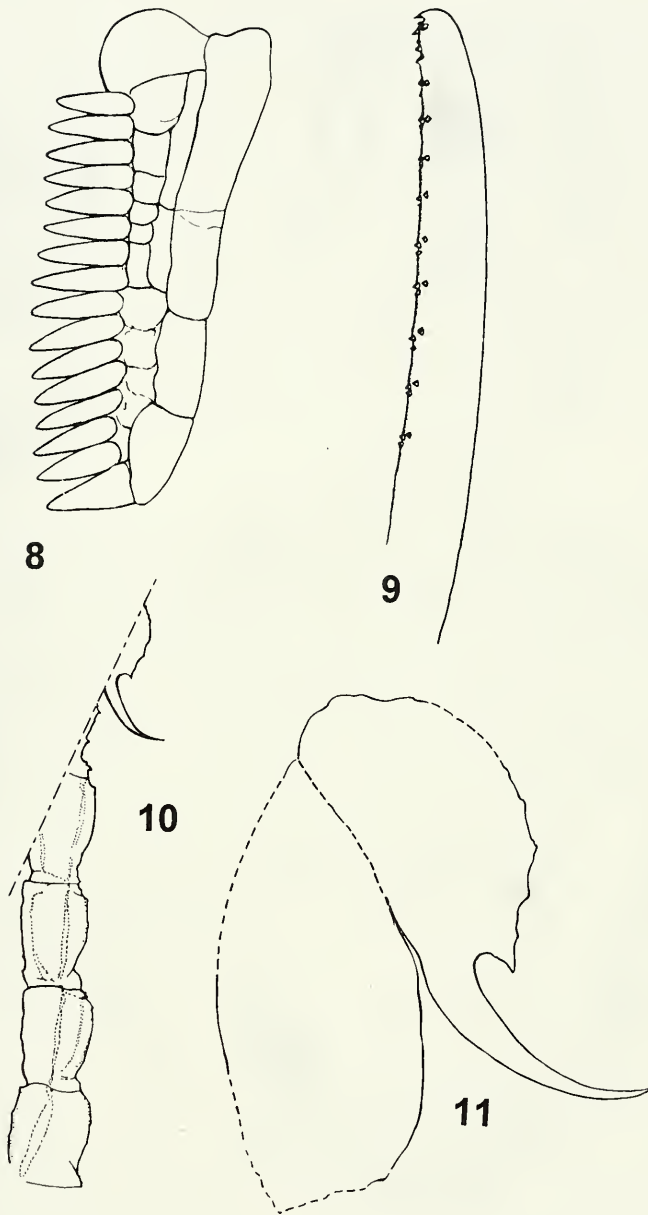
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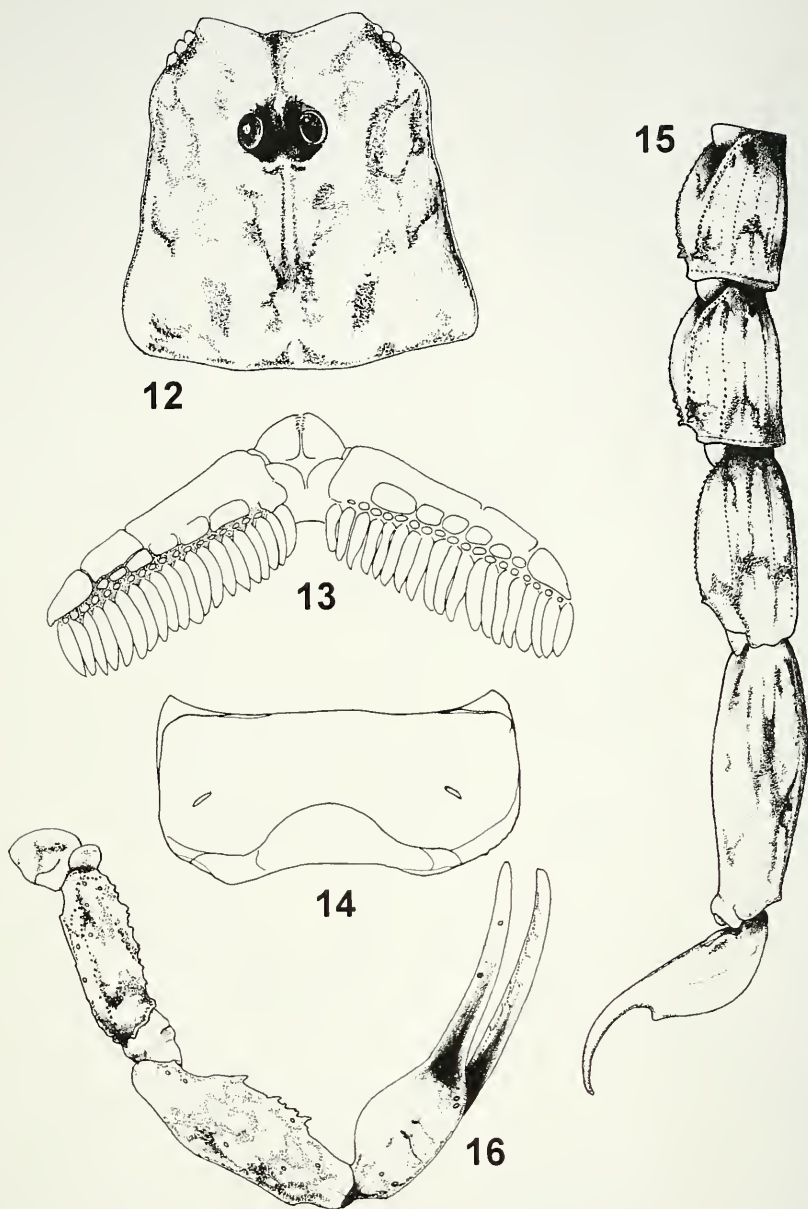
FIGS 1-7

Male holotype of *Troglotityobuthus gracilis*. 1. Carapace, dorsal view. 2. The same, lateral view. 3. Sternite V. 4. Metasoma and telson, lateral view. 5. Movable finger of pedipalpal chela. 6. Pectines. 7. Pedipalp, dorsal view with trichobothrial pattern.



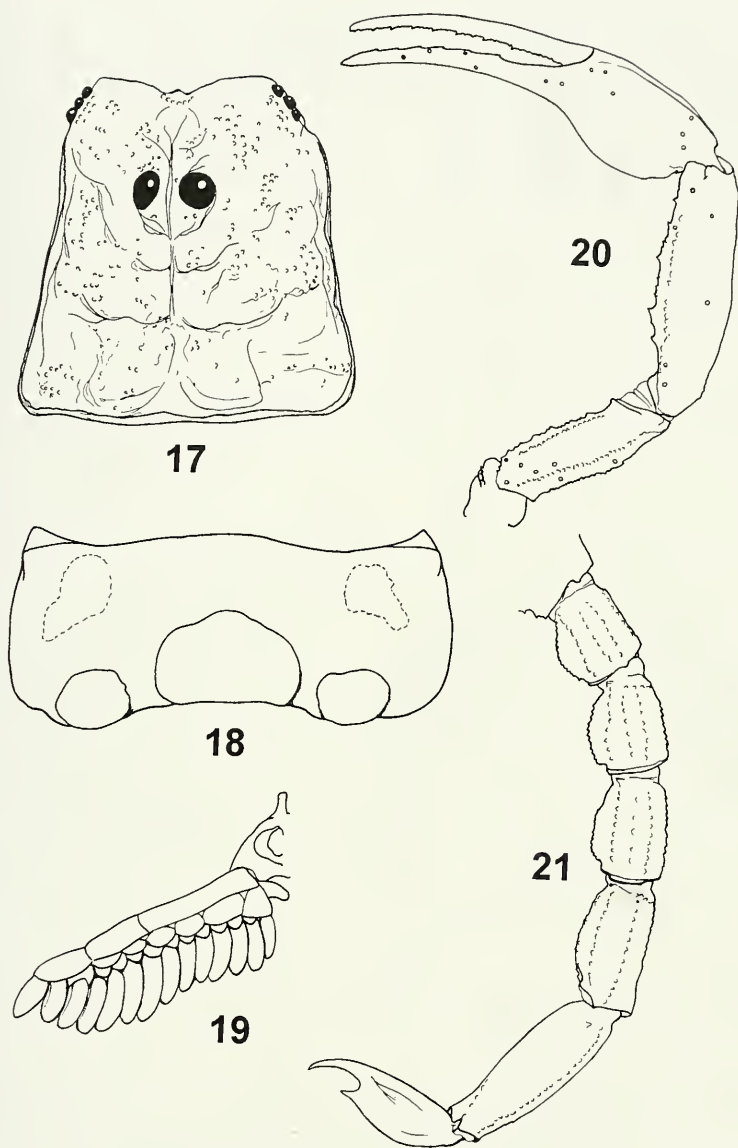
FIGS 8-11

Male holotype of *Palaeogrosphus copalensis*. 8. Left pecten. 9. Movable finger of pedipalpal chela. 10. Metasoma and telson, lateral view. 11. Metasomal segment V and telson in detail, lateral view.



FIGS 12-16

Male holotype of *Tityobuthus manonae* sp. n. 12. Carapace. 13. Pectines. 14. Sternite V. 15. Metasoma and telson, lateral view. 16. Pedipalp, dorsal view with the trichobothrial pattern.



FIGS 17-21

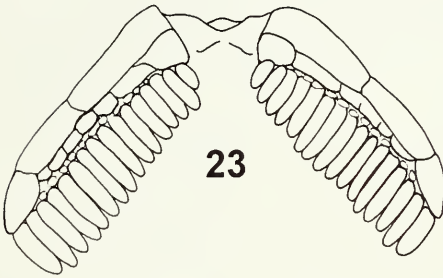
Male holotype of *Tityobuthus griswoldi* sp. n. 17. Carapace. 18. Sternite V. 19. Pecten. 20. Pedipalp, dorsal view with trichobothrial pattern. 21. Metasoma and telson, lateral view.



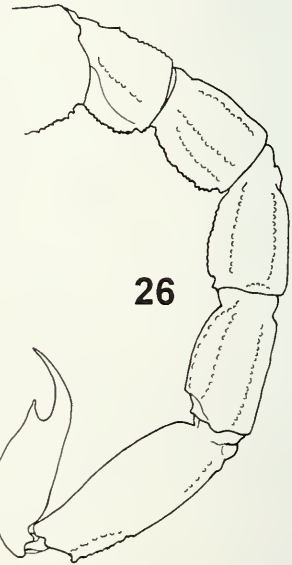
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FIGS 22-26

Male holotype of *Tityobuthus monodi* sp. n. 22. Carapace. 23. Pectines. 24. Sternite V. 25. Pedipalp, dorsal view with trichobothrial pattern. 26. Metasoma and telson, lateral view.

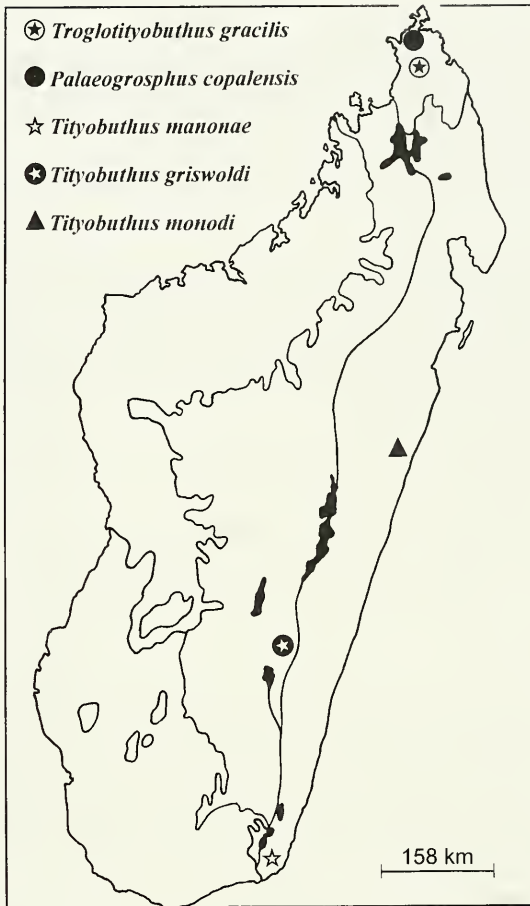


FIG. 27

Map of Madagascar showing the type localities of the new genera and species described in this paper.

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